## XXXIII.—*Organographic and Physiologic Sketch of the Class Fungi*, by C. Montagne, D.M. *Extracted from* 'Histoire physique, politique et naturelle de l'île de Cuba,' par M. Ramon de la Sagra, *and translated and illustrated with short notes by the* Rev. M. J. Berkeley, M.A., F.L.S.

[Continued from p. 236.]

### *Hymenomycetes*, Fr.

These Fungi, which compose the highest family of the class, are characterized by an hymenium composed of utricles or exosporous asci*, in contradistinction to that of *Discomycetes*, in which the asci are endosporous. But the differences are not confined to this single character; the receptacle itself, on which the hymenium is spread, is not only more varied in its form, but more complicated in its organization.

I will follow step by step this organization, from the formation of the mycelium or vegetative system to the production of the spores, and in this rapid review will endeavour to omit none of the numerous modifications which the different organs undergo in the successively decreasing series of genera and species.

The mycelium does not always appear under the same form; it presents flakes of white filaments loosely interwoven, fibres or roots; or it spreads out in smooth or radiating membranes of the most delicate tissue (*e. g. Himantia*); or finally, it creeps under the bark of trees or amongst the very fibres of the wood forming those black lines or spots which we so frequently observe. Fries remarks that in most cases the mycelium is perennial; that it is on this account we find it barren, and that it produces fruit only after a given time in each species, and under certain meteorological momenta. These conditions are, as everyone knows, heat and moisture. If light is not as necessary for the perfect evolution of the mycelium, since, on the contrary, it is in caves and mines that it acquires a greater degree of development, it is indispensable to that of the fructification which it is destined to produce†. As in plants of a higher order, it is to its overgrowth that the sterility of the fungus is due. These vegetables are not then nocturnal plants, as has been falsely asserted. I have already explained the nature of the filaments which compose the mycelium: as it varies little in outward appearance, still less in its structure at the time of its first appearance, I shall not return to the subject.

At a certain epoch not easily appreciable, and variable in each

* The word *ascus* is scarcely appropriate here. The utricles are in fact the same organs as the stem of *Botrytis*, as will be seen by comparing *Botrytis curta*, Berk., or any species of the *B. parasitica* group.—M. J. B.

† *Cantharellus Dutrochettii*, Mont. (*C. crucibulum*, Fr. Ep.), nevertheless passes through all the phases of its morphosis on bottle-racks made of deal, in the darkness of cellars. [It may however perhaps be doubted whether this and *A. pannoides*, which is perfected in the same situation, are autonomous species. The remark however will hold good of *Merulius lacrymans*, &c.—M. J. B.]

species, there appear upon the mycelium one or more little ovoid or spherical tubercles, whose successive increase shows what species we have before us; for at first all are concealed under a more or less dense spidery web, which the greater part cast off before completing their evolution, but in which some always remain enveloped. In this respect we cannot overlook the striking analogy which exists between the whole class of Fungi and that of insects, an analogy already recognised and pointed out by the illustrious Fries. The veil with which I said the tubercles were covered is sometimes woven into a membrane of greater or less thickness, and more or less tough, which, after having enveloped the fungus, as the elements of an egg in its shell, at last bursts at the summit or on the side, and gives it free access to air and light. This membrane, which is called volva (*velum universale*), frequently remains at the base of the peduncle, and then affords excellent characters for specific distinctions. Sometimes it bursts circularly around the pileus, and its upper hemisphere glued to its surface, forms spots or discoloured warts, as in *Agaricus muscarius*. In other cases it is entirely resolved into persistent scales. Sometimes it is formed of a byssoid web so delicate that not the least trace is to be found. Besides the volva, which is wanting in many genera, many *Hymenomycetes* are supplied with a second envelope, which, after its rupture, remains frequently upon the peduncle under the form of a collar or ruffle; this is called a ring (*velum partiale*). It is complete when it encloses the whole pileus; incomplete when, being fixed on its border, it covers only the gills.

The ring, which is generally white, is membranous or arachnoid, persistent or fugacious, adhering to the peduncle, or free and moveable. Its upper or inner surface has frequently striæ which correspond to the gills with which it has been in contact. It is fixed at different heights upon the stem; most frequently at about a third from the top. But the partial veil is not always membranous; in one tribe of the genus *Agaricus*, an arachnoid web unites at first the border of the pileus to the stem. This extremely delicate web, which is named curtain (*cortina*), is composed of white or coloured threads, and leaves traces of its existence either on the stem or on the margin of the pileus.

The peduncle or stem (*stipes*) is that part of the fungus which, when it exists, springs immediately from the mycelium and supports the pileus. Its presence is not essentially necessary, since it is wanting in many species, which are therefore named apodi or resupinate. In those which are provided with it, it either occupies the centre of the pileus, in which case it is called central (*mesopus*), or else it is eccentric (*excentricus*), or it is seated at the very edge of the pileus (*pleuropus*). The stem may be cylindrical or fusiform, or swollen and bulbous at the base, solid and stuffed, or fistulose, either from the first or consecutively, smooth and uniform or flaky, tomentose, villous, &c., annulate or ringless, same- or party-coloured, soft, elastic, fibrous and tough, or even woody in certain species.

When it is altogether wanting, or the pileus is attached immediately to the matrix by a greater or less portion of the border, it is

called stemless (*apus*); or if applied by its whole upper surface, which is thence become inferior, it is called resupinate.

The stem is dilated above into an organ of various forms, but usually orbicular or flabelliform, which is called pileus, or, which is better, hymenophorum, since this term is applicable to tribes whose hymenium clothes a claviform or branched receptacle, not having consequently the least resemblance to a hat.

The hymenophore, which is membranaceous, fleshy, coriaceous or corky, assumes the most different forms. Sometimes it is a sort of convex, hemispherical, campanulate, ovoid, conical hat; sometimes depressed in the centre, and infundibuliform, or altogether plane, or even with its border turned up (*e. g. Agaricus, Boletus, Polyporus,* &c.); sometimes it forms simple or branched clubs (*Clavaria*); sometimes cup-shaped membranes (*Exidia*), or sinuous folds and plaits (*Tremella*). In stipitate *Hymenomycetes* the pileus is always, even when it becomes separable from it, an expansion of the flesh of the stem, and composed of the same elementary cells, sometimes however slightly modified.

In *Agaricini* the pileus is horizontal, and bears beneath plates or gills (*lamellæ*), whose central substance is formed by membraniform processes (*trama, dissepimentum,* Fr., subhymenial tissue), which are given off at right angles to this surface, and radiate from the centre to the circumference: these plates are simple or equal when they are of the same length, or compound when they are unequal in length; that is to say, when between two long gills there are other shorter ones which measure only a third, a fourth, &c., of the radius of the pileus. In this case Krombholz calls them didymous, tridymous, tetradymous, or polydymous, as half, third, or quarter gills, &c., are interposed. They are more or less close and numerous, thin or thick, broad or narrow, straight or ventricose in their free edge: in relation to the stem they are variously circumstanced, being sometimes fixed to it either by their whole breadth or by running down the stem (*decurrentes*); or they are attached by a less portion than the whole breadth, in consequence of their being rounded off at the point of attachment; or, before they attain this point, there is a portion cut out as it were, in which case they are said to be sinuate. The free or lower border of the gills is entire or toothed, straight or ventricose, equal or undulated, acute or obtuse, sometimes channeled or cleft longitudinally, as in *Trogia* and *Schizophyllum*. As regards consistence, they are fleshy, membranous, coriaceous, watery, milky, flexible, or brittle, &c. Their colour is very variable, and presents every shade of white, black, rose-colour, violet, brown, &c. Lastly, they are persistent or deliquescent, as in *Coprinus*. In the genus *Montagnites* (*Agaricus radiosus,* Pall.) not only are they persistent, although they become black, but, which is very remarkable, they remain still fixed by a short filament round the top of the stem after the destruction of the hymenophore. In *Cantharelli* the gills are so narrow that they are reduced to simple dichotomous or branched folds. In *Merulius* these folds anastomose and form a network, which indicates a passage from *Agaricini* to *Polyporei*.

The hymenophore of *Polyporei* produces tubes instead of gills. In *Boletus* these tubes, which may be regarded as gills rolled round (a view which is confirmed by the structure of *Fistulina*), adhere loosely; and, as the trame of the pileus does not pass into them, they are easily separated without injury. It is not so with *Polyporus*, the trame of the pileus supplying the skeleton, as it were, of the tubes or pores which the hymenium lines; they cannot therefore be separated from the hymenophore, or from each other, as in *Boletus*. The pores vary in form and size. Sometimes, as in *Dædalea*, they are deep labyrinthiform sinuses formed by frequent anastomosing of agaricinoid gills; sometimes they are in the form of five- or six-sided alveoli, as capacious and as regular as the cells of bees; sometimes these pores are so minute as scarcely to be visible by a good lens. All intermediate conditions are found. They are round or angular, regular or irregular, short or long, equal or unequal, simple or disposed in layers (stratose), &c. The substance which separates them is called dissepiment. Their colour, though variable, is perhaps less so than in *Agaricus*. Their aperture (*os*) affords good characters; it is sharp or obtuse, entire or toothed, torn, velvety, &c. Their cavity is often clothed with a glaucous or silvery substance. In *Glœoporus*, the pores, which are almost imperceptible in a dry state, have not their dissepiments formed by the trame of the hymenophore, but are hollowed out in a gelatinous hymenium, heterogeneous and of a different colour, analogous to that of *Auriculariæ*, to which this new genus forms a transition.

The hymenophore of *Hydna* is bristly below, with teeth or prickles (*dentes, aculei*), sometimes with simple tubercles, as *Radulum*, or seriate interrupted gills, as *Sistotrema*; these prickles are of greater or less length, more or less voluminous, and approximate. The distinct aculeiform tubes of the genus *Fistulina* are not separable from the pileus, from whence we may infer that they are formed from the trama, and that this genus forms the transition from *Polypori* to *Hydna*. In all the other genera of the tribes the prickles are solid, and very variously formed and coloured. As in the preceding and following tribe, the hymenophore offers the same variations as we have already made known in *Agaricini*, that is to say, that it is sessile or stipitate, with the stem central or lateral, entire or dimidiate, frequently reversed, and in this case reduced sometimes to a thin layer of arachnoid tissue, pulverulent as it were, from whence the prickles arise. Lastly, that of *Auricularineæ* is raised sometimes into radiating veins (*Cymatoderma** = *Cladoderris*, P.), into mammillæ, as in *Grandinia*, or into papillæ, as in *Thelephora*, or perfectly smooth, as in *Stereum*. The hymenophore of *Clavariæ* is vertical, simple or branched, rarely foliaceous, the upper portion being linguiform,

* Judging by the figure and description, I suspect that this genus, lately established by Junghuhn (Tijdschr. voor Natur. Geschied. en Physiol. 2–3 stuck, 1840) on a fungus of Java, scarcely differs from *Thelephora dendritica*, Pers., gathered in the island of Rawak by M. Gaudichaud, on the expedition of the Uranie, commanded by M. Freycinet.—See Mont. Ann. Sc. Nat., Nov. 1841, and Berk. Hook. Lond. Journ. Bot. No. 3.

clavate, or ending in a sharp or obtuse point. In *Tremellæ* it is foliaceous, decumbent, sinuous, plaited, or smooth and gelatinous.

Having gone through the forms of the hymenophore, let us now examine its structure. In general two different tissues enter into its composition: one consists of cells which are at first spherical, but which become polyhedral by mutual pressure; the other of septate filaments, generally of a very small diameter. The union, intermixture and felting of these elementary tissues not only determine the gelatinous, spongy, fleshy, or corky or woody nature of this organ, but produce, moreover, the many forms which they present. We must not forget that the central layer (*trama*) of the gills of Agarics, of the prickles of *Hydna*, of the dissepiments of *Polypori*, &c., being formed by prolongations of the tissue of the hymenophore, is consequently, in the majority of cases, composed of the second order of cells, that is to say, the elongated; sometimes, nevertheless, covered by another thin layer of globular cells, which separate it from the sporigerous membrane; and that in *Russula* and *Lactaria*, whose trama is altogether composed of these cells, it is from these very cells that those proceed, which, under the name of basidia, anthers, paraphyses, &c., concur in the formation of the hymenium. There is still a very important fact, should it be confirmed, and which, in any case, I ought not to pass by in silence, viz. the presence of laticiferous vessels in some species of this family. Their discovery is due to M. Corda, who assures us that he has seen them in *Russula fœtens*. According to this mycologist, who has also figured (Ic. Fung. iii. p. 42, t. 7. f. 106, *g*, *i*, *k*, *l*) this vascular system, whose existence has never been suspected, the laticiferous vessels are continuous, pellucid, equal, generally flexuous, much branched, and frequently anastomosing by means of collateral branches. They contain (I am still speaking of *Russula fœtens*) a milky, semitransparent, opaline juice, filled with molecules, and which appears to move slowly in different directions. These vessels are more numerous in the gills of *Russula fœtens*, and on the surface of the stem, than in the parenchym of the pileus or peduncle. They contribute, moreover, according to Corda, to the formation of the hymenium in this Agaric, descending between the basidia under the form of cæciform tubes, attenuated at first at the extremity, and then terminated by a globular swelling (*l. c.* fig. 106, *g*, *i*)*.

The parenchym of many *Hymenomycetes* presents the very curious phænomenon of becoming blue when, after being torn or broken, it is put in contact with the atmosphere (*e. g. Boletus cyanescens*).

We have seen that in *Discomycetes* the hymenium consists of cylindrical or claviform tubular cells, placed parallel to each other, and each containing eight sporidia arranged in a single row; in other words, that it is composed of endosporous asci: that of *Hymenomycetes* presents a structure almost similar as regards the cells and their disposition, but instead of being included, the sporidia, most fre-

* See moreover the ideas on this subject put forth by M. Morren, Acad. Roy. des Sc. Brux., 5 Janv. 1839.

quently quaternate, are seated on their apices; in other words, these organs are exosporous.

As is the case with the male organs of *Targionia*, this organization, correctly seen and tolerably figured by Micheli * a century since, and in more recent times by Bulliard, had been cast into oblivion by the most celebrated botanists of our times, who had lost the trace of it. It is but a short time since it has been called to mind and established, that the immortal Florentine, with very imperfect instruments, had nevertheless very correctly observed nature, and was the only one who had done so†.

The paraphyses (*Basilarzellen*, Corda) are elongated, tubular, cæciform cells, placed parallel the one to the other, like the pile of velvet. In most cases they are the termination of the filaments of the parenchym of the hymenophore, or of the trame of the gills of Agarics, the prickles of *Hydnum*, &c. Some, as is the case also with basidia, are furnished even by the outermost of the two layers of cells which accompany the trame.

The basidia (Lév., Cord., sporophores, Berk.) placed between these paraphyses, and, like them, tubular, are distinguished not only by their being rather longer, which makes them project perceptibly beyond the surface of the hymenium, but, besides this, because they contain, before the maturity of the sporidia, a coloured opake juice, clouded by an innumerable quantity of granules and some drops of oil,

* Micheli indeed observed that the sporidia were exogenous, and he has figured their quaternate arrangement in *Coprinus*, but it is not correct that he was acquainted with the basidia; the bodies figured by Micheli, which have been supposed to be what has been lately observed by so many mycologists, being merely the little hairs with which the gills are often fringed. This will at once be found to be the case if the letter-press be compared with the figures. On pointing this out to Dr. Montagne, whose love of science is equalled by his love of truth, he most kindly and candidly replied, "J'ai revu les planches de Micheli que vous citez et relu le texte. Il parait par celui-ci que ce savant n'a pas vu le fond des choses, et à cette époque, certes il est étonnant qu'il ait même si bien vu. Je conviens avec vous qu'il n'est pas le moins question du monde des basidies dans le texte, mais Micheli y parle très clairement de la disposition quaternaire des spores, qu'il indique pl. 73, fig. *h*."

Müller's figure of *Ag. comatus* shows correctly the sporidia seated on the spicules of the basidia. The eyes of modern mycologists were for years blinded by Link's celebrated paper, or the real structure would long since have been recognised. The modern re-discovery is due to Ascherson; at least he is the first who made it known.—M. J. B.

† An excellent history of this subject may be found in the memoirs of Berkeley and Léveillé on the hymenium, and in the third volume of the 'Icones Fungorum' of Corda, who claims the honour of having first conducted naturalists into the path of truth. None of these authors mention the opinion which Palisot de Beauvais proclaimed in 'Encyclopédie Méthodique,' in the article *Champignons*. This savant holds, that the bodies which Micheli took for spores are not the true seeds, but an heterogeneous powder which the wind carries upon the gills or the eggs of insects. The grains, he says, are enclosed in the gills between their coats. [This is of a piece with his eccentric notion, that the reproductive bodies of mosses are contained in the columella.—M. J. B.]

which, in proportion as the evolution of the sporidia is perfected, gradually clears and at length becomes transparent. This juice, during life, is subject to an evident motion analogous to that which we have observed in *Botrytis Bassiana*, *Ascophora Mucedo*, &c. From the summit of the basidia spring threads (*sterigmata*, Corda [spicules, Berk.]), generally four in number (*basidia tetraspora*), destined to support the reproductive bodies. The number of these threads is normally four, and then they are, as it were, verticillate at the free extremity of the basidium, and disposed thus : : at the four angles of a square; but sometimes there are but two, the others being abortive. They may even be reduced to unity; but occasionally there are two additional threads, raising the number to six (*basidia polyspora*), placed at the extremities of the major axis of an ellipse thus · : : · ; or finally, by the suppression of one, the number is reduced to five : : ·. These threads or peduncles are frequently swollen at their point of attachment and apex. In some genera with monosporous basidia (*e. g. Tremella*) the support is wanting, the sporidium resulting then from a sort of strangulation of the tip of the basidium. The threads are hollow, and communicate with the cavity of the basidia, that the juices which contribute to the nourishment and increase of the sporidia may reach them without any impediment.

The sporidia, the object and end of vegetation, are bodies destined to reproduce the fungus. In the whole family with which we are occupied, these bodies are outward or acrogenous, and not enclosed in special cells or endogenous, a character which approximates them to *Mucedines*, in which are some genera (as *Isaria*, *Ceratium*, &c.) which Messrs. Berkeley and Corda associate with *Hymenomycetes*, the genus *Clavaria* forming a natural transition. The sporidia, which are spherical, oval or oblong, straight or curved, smooth or rugged, naked or echinulate, one- or more celled (*e. g. Gomphus rutilus*), are composed, as in the majority of species of this vast class, of an episporium and a nucleus, sometimes accompanied by some drops of an oleaginous substance, held in suspension in an opaline fluid, at length grumous, which circulates in the basidia even after their complete evolution. The episporium, formed of a single indehiscent cell, bears at the point of attachment (at least in the species where this is evident) either a little cavity, named by Corda hilum (Ic. Fung. iii. t. 8. fig. 115, *h*), or a little conical obtuse or pointed nipple (*l. c.*, t. 7. fig. 99, *h*), indicating the place of the ancient aperture by which the granular fluid (*massa sporacea*) of the basidia penetrated into the cavity of the episporium, before the formation of the nucleus. This hollow or nipple is moreover the point by which the sporidium was attached to the thread. As regards their direction, if they have, as in *Mucedines*, the same axis with the sterigma, Corda calls them *trepanotropous**; if, as when they are attached laterally, their axes are different, they are called *pleurotropous*. These epithets are applied to the sporidia alone, when the direction of their axis is compared with that of the axis of the threads. The

* I should prefer orthotropous or homotropous.

nucleus is usually consistent, rarely fluid, and at length assumes, within certain limits, various colours. They are white, rose-coloured, ochraceous, ferruginous, purple-brown, or black; and Fries, in the 'Systema Mycologicum*,' has availed himself of the fact, that the same colour prevails in allied species, to form the principal sections in the methodic distribution of the genus *Agaricus*.

The anthers (*antheræ*, Klotzsch, *cystidia*, Lév., *antheridia, pollinaria*, Corda) are a third kind of vesicular or tubular cells which occur in the hymenium of some Agarics and many *Boleti*. According to Corda, these cells do not arise from the trama descending from the pileus, but their base is lost amongst the cells of the nearest of the two layers usually interposed between the trama and hymenium. This is at least the result of the examination of the greater part of the figures in which he has figured these organs. Sometimes, in certain *Coprini* for example, the anthers are even placed in a little hollow in the surface of the hymenium, which they considerably exceed. These organs, which Micheli considered as buttresses destined to keep the gills separate from one another, and to prevent their mutual agglutination, because doubtless he had not observed them in the tubes of *Polypori*, where the notion is inapplicable; these organs, to which Bulliard already attributed a fecundating property, though he confounded them with others which have not the least analogy with them; these organs, finally, whether regarded or not as grains of pollen sprinkled over the surface of the hymenium†, are formed of a single indehiscent, extremely thin and transparent, cylindrical, conical or acuminate cell, filled with a mucilaginous, limpid, colourless juice, or rarely coloured by a light tint of yellow or bistre‡, in which float extremely fine molecules. This mucilage, at a later period, exudes from the cell, and appears at its tip in the guise of rounded drops. Corda assures us that the anthers appear before the evolution of the basidia, and that they disappear when the sporidia are mature. It is to the viscid nature of the juice which they pour out that we must attribute the agglutination of the spores round the cystidia of Léveillé, when these reproductive bodies have abandoned their supports. The organs considered as endowed with the property of fecundating the sporidia have been observed in a certain number of species only, which however should not invalidate the opinion of the authors who assign them this distinction, since even in Mosses, where the presence of these organs is averred, there are a great number of species in which they could not be found.

* In a later and newly published work, 'Epicrisis Systematis Mycologici,' he has attempted a new arrangement of the genus, founded principally upon the structure of the trama of the gills or subhymenial tissue; but we do not find that he has rendered the determination of the species of this difficult genus more easy, and we still prefer the former arrangement, with a few exceptions. [In this opinion of Dr. Montagne I most entirely concur. I do not know in the whole field of Botany a more masterly effort of genius than the arrangement of this genus in the 'Syst. Myc.'—M. J. B.]

† Corda (Ic. Fung. iii. p. 44) establishes this comparison, and supports it by observations and reasoning which appear conclusive.

‡ In *Ag. balaninus*, Berk., they are of a deep purple.—M. J. B.

The hymenium whose structure I have just described covers the two faces of the gills of *Agaricini*, and the whole surface of the prickles in *Hydna*, by being reflected upon the hymenophore in the interval which separates them; penetrates into the interior of the tubes or pores of *Polypori*, clothes the whole surface of *Auricularini*, and the upper surface only of *Clavariæ*, and extends finally into the sinuosities of *Tremellini*, with the gelatinous substance of which it is frequently confluent.

The *Hymenomycetes* are fungi which flourish and increase most abundantly in temperate climates. Nevertheless, even under the tropics, where the negligent manner in which they have been looked for has induced a supposition that they are more rare than they really are, there are certain localities in which their number and variety are not less than with ourselves. Besides, in Europe, their development is subordinate to the seasons, and the greater number appear only in autumn, the most favourable time for their growth, because of the joint heat and moisture. In equatorial countries, on the contrary, according to Junghuhn (Communic. sur Java, Ann. Sc. Nat. Bot., 2 sér., tom. vii. p. 170), besides that the species of this family are at least as abundant* as in our climate, their reproduction goes on during the whole of the year. M. Leprieur has observed the same fact in Guiana. With us the summer and autumn are the seasons which favour and expedite the evolution of the greatest number of *Agaricini*, *Polypori*, &c. Spring is less propitious, and winter produces a few rare species only of these tribes. Amongst *Hymenomycetes*, some are common to a great many countries, others are found only within certain limits (*e. g. Ag. olearius*, *Pol. Tuberaster*); some, amongst which it is remarkable that we must reckon *Ag. campestris*, the only species eaten at Paris, are cosmopolites. *Schizophyllum commune* is also of this number.

Fungi of this family flourish especially on wood, at the foot of trees or on the trunk, on dead or rotten wood, on dry branches fallen on the ground, on living mosses, and in general on all organized, diseased, or dead bodies. We find them likewise in fields and meadows. They grow solitary or grouped together (*gregarii*), or united into a mass (*cæspitosi*). Sometimes they form by being disposed in concentric circles, what were named fairy rings, because people were absolutely ignorant of the cause of their production. Perhaps we are as ignorant at the present time as to the ultimate cause; but if I mistake not, we may give a plausible explanation of the proximate cause, that is to say, of the concentric disposition of the circles. This appears to result from the circular dispersion of the spores of the preceding year, perhaps also from the eccentric vegetation of the mycelium; that is to say, outside the last circle

* They are probably much more so in proportion to the whole number of species. In Junghuhn's 'List of Fungi of Java,' given by Dr. Montagne in Ann. Sc. Nat. Nov. 1841, out of 113, 66 are Hymenomycetous; and the proportion is still greater in a collection made by Cuming in the Philippine Isles.—M. J. B.

only*. An analogous instance, though in miniature, is found in *Oidium fructigenum*.

The colour of Agarics, *Boleti*, &c., has attracted the attention of some observers. We will consider it both in the hymenium and hymenophore. The colour of the hymenophore of Agarics and *Boleti* is not constant in the same species; it may be white, red, blue, brown, olive and yellow (*e. g. Russula emetica, Boletus scaber*), without any variation in the other characters. The colour of the hymenium is less liable to vary in the same species, and when such a variation does take place, it is usually due to advance in age. Thus, in *Pratellæ*, the gills are at first rose-coloured or violet, and at last become black. In *Coprini*, from white or gray they pass to black at the time of their deliquescence. As regards the proximate cause of the colour of Fungi, it appears, after the observations of Morren†, that it is attributable to the presence of spherical corpuscles of $\frac{1}{300}$ of a millemetre circulating in the tubular filaments whose interlacing forms the hymenophore, or free and dispersed in their interstices, but not possessed of any motion in either case. Their colour is more intense in proportion as they are nearer the outer surface of the fungus; that is to say, as they are more immediately influenced by light.

As to duration, it is ephemeral in a great number of Agarics; in the fleshy species it is in general from seven to fifteen days; some, however, last longer. In the perennial *Polypori* it extends to many years; but these species increase by the successive production of new layers, which every year are deposited on those of preceding years.

It is in this family that we find the most delicious Fungi, as, for instance, *Agaricus cæsareus* (*Cibus Deorum*, Clus.), or the true *Oronge*, *A. campestris*, *A. prunulus*, *Boletus edulis*, &c. But amongst them we find also the most violent vegetable poisons, and this even in certain species which unhappily, without long study, are too easily confounded with the most wholesome fungi. I cannot here enter into any detail relative to the culinary preparation of good species, or the means of remedying accidents caused by partaking of bad fungi. On these points, the general works which treat on these productions, or those which relate to toxicology or medicine, may be consulted, and in particular 'Traité des Champ. Comest.' by Persoon, or the treatises of Messrs. Roques and Cordier. The article *Agaric*, in 'Dictionnaire universelle d'Histoire naturelle,' by my friend and fellow-labourer Léveillé, will also give valuable information on this head. There are still some uses to which these

* This last explanation is admitted by Dutrochet, Observ. sur les Champ., Ac. des Sc. Paris, 3 Mars, 1834. [It appears, from measurements which have been accurately taken, that fairy rings increase annually in diameter, which accords with this notion, and the dark colour of the grass is doubtless owing to the stimulating power of the mycelium.—M. J. B.]

† See note on *Agaricus epixylon*, Bull. (*A. applicatus*, Batsch), Acad. Roy. Sc. de Bruxel., 5 Janv. 1839.

plants are put, as well in domestic economy as in medicine, but we have touched on these before in the general introduction. In the economy of nature, besides that they hasten the decomposition of organic substances which supply the office of matrix to them, and with which they unite in forming humus or vegetable soil, they moreover serve to nourish a multitude of insects, worms, mollusks, &c. It is believed that they help to purify the atmosphere by absorbing certain deleterious gases.

I have not yet spoken of *Phylleriaceæ**, which Fries has placed in an appendix at the end of the class. They have lately been considered as a luxuriant growth of the superficial cells of the parenchyma of leaves, the only organs indeed on which they occur. I am inclined to think that such is their origin. M. Fée attributes their presence to the larvæ of insects, which stimulate the leaves and elicit the anomalous development of elongated, coloured, frequently transparent, simple or septate cells, forming a more or less dense mass on living leaves, which are in consequence often deformed. Nothing like spores has been discovered. The genera which compose this tribe, of which I have one or two species to describe from Cuba, are *Taphrina, Erineum, Septotrichum, Phyllerium.*

In this short and rapid sketch I have considered successively the Fungi of the whole class, in their varied and gradually more complicated forms; and, as far as my powers and my limited space have allowed, I have endeavoured to collect everything new and interesting which has been published respecting them during a period of nearly fifteen years; to unroll before the eyes of the reader, under the form of a simple, though necessarily imperfect sketch, the vast tablet representing the actual state of mycology under the twofold relation of organography and physiology. To close this difficult attempt, which I should not have ventured upon if it had not been imposed by the plan adopted in this work, and of whose success I am not very confident, I must still add something on the chemical composition of these plants, and of their reproduction, considered in a general manner.

The analyses of Vauquelin and Braconnot had caused chemists to recognise and admit in these plants principles which the recent and well-known labours of my learned colleague M. Payen on vegetable substances have definitively erased from the catalogue of simple substances of organic chemistry. Thus, for instance, *Fungine*, considered as a simple body, according to this excellent chemist, is but a mixture of *cellulose* and fatty matter. M. Payen having had the extreme kindness to communicate to me the result of his analyses, I am able to give the following list of elementary substances which enter generally into the composition of Fungi:—1. water; 2. cellulose, constituting all the solid part of the membranes of the tissue; 3. three azotous substances; one insoluble in water; a second soluble, co-

* Fries, Syst. Myc. iii. p. 519. Fée, Mém. sur le groupe des Phyllériées, 8vo. Paris, 1834. Grev. Mon. Erin. in Ed. Phil. Jour., p. 67. Schlecht. Mon. Erin. in Soc. Roy. Ratisb. 1822. Kunze, Mon. der Gatt. Erin. in Myk. Heft ii. p. 117, Leipz. 1823. Corda, Ic. Fung. iv. p. 1.

agulable by heat; a third soluble in alcohol; 4. fatty matter analogous to wax; 5. fatty substances; one fluid at an ordinary temperature, the other solid, crystallizable at the same temperature; 6. sugar; 7. matter capable of being coloured brown by the action of free air; 8. an aromatic substance; 9. traces of sulphur; 10. traces of salts of potash and silex *.

The reproduction of Fungi has been a subject of long and lively controversy; but I think modern observations, by clearing up the question, have induced a more uniform opinion, and one more nearly approaching truth.

It was long believed that their production was due to an equivocal generation, or simply to the decomposition of organized bodies. It is to Micheli that we owe the experiments which have passed sentence on this erroneous opinion, which, however, was held recently by some distinguished botanists. The proverb *nihil de nihilo* is here applicable, and I can scarce bring myself to believe that spontaneous or equivocal generation has any supporters amongst botanists. But amongst those who do not deny that a sporule can germinate, there are some who nevertheless cling to equivocal generation, admitting those transformations from whence it would result that a species, instead of producing a being identical with itself, would give birth to another species of a different genus or even family. This error is due to the fact, that in order to the production of the fructification, or in other words, what we term the fungus itself†, the vegetative system requires a greater or less length of time, sometimes even many years. Suppose that the sporidia of a *Clavaria* have given birth to an *Himantia*; who does not now know that this production, which has erroneously been constituted a genus, is nothing but the *mycelium* or organ of vegetation, from whence at some more distant epoch a *Clavaria* would have arisen identical with that from whence the *mycelium* sprang? And, as Fries expresses himself very judiciously on this subject‡, "*At num e seminibus Pyri Mali satis mox pomum habebis? Primum sine dubio enascetur arbuscula; sic inter Fungos* mycelium." There is no fungus of the six families which we have reviewed which does not normally bear sporidia. Are these then mere *lusus naturæ*? This notion is repugnant to reason and common sense. We must then admit that, as in all organized bodies, these sporidia are not, cannot be anything but organs destined for the reproduction of the species. Besides, that which reason counts for probable, observation and direct experiment have put completely beyond doubt.

The most curious fact in the physiology of Fungi is perhaps that of the kind of copulation which we observe amongst the branches of *Syzygites megalocarpus*, Ehrenb. This phænomenon is analogous to

* It is curious that the greatest proper heat met with by Dutrochet in the vegetable kingdom, with the exception of that of the spadix of *Arum*, was in *Boletus æreus*.—See Ann. Sc. Nat., Feb. 1840.—M. J. B.

† *Totus fungus pro merâ fructificatione habendus est.* Fries, Lichen. Europ. Proleg., p. xx.

‡ Ecl. Fung. in Linnæa, v. p. 503.

that which takes place in *Conjugatæ* of the class Algæ, and especially in the genus *Closterium*. The tips of two branches approach, join, and form by their junction a verrucose sporangium, in which the spores appear to result from the mixture of the contents of the two. But this mixture, as we may easily imagine, cannot take place without the resorption of the septum at the point of juncture, which in fact takes place. Nevertheless, it would appear that the copulation is not indispensable to the accomplishment of the function, since, when the two branches do not touch, a single sporangium is formed at the extremity of one of the two, or else, though more rarely, one appears on each extremity*.

In their germination, which is not now matter of controversy, there is a simple elongation of a single pole, or of two opposite poles, of the epispore of the sporidia (*mono-dinema*); or else, according to Corda (*l. c.* ii. p. 26, t. xiii. fig. 97, No. 21), this bursts like the testa in the true seeds of Phænogamous plants, to make way for a filament susceptible of reproducing the plant from whence it emanates, or at least of concurring in its reproduction. It appears, indeed, to be averred, that in many fungi, especially amongst those which are highest in the series, one, or even several sporidia are not sufficient for the production of a new individual. Nature, in infinitely multiplying the number of seeds in these plants, seems to have wished to initiate us into the secret of their propagation. The mycelium, which arises from the germination of the sporidia, should seem to be unable to work the almost instantaneous growth of an Agaric; for example, if it were composed of too small a number of filaments, themselves limited in their vegetative powers. It is then, in this case, only by the simultaneous concourse of an immense number of sporules that we can hope to obtain the desired result. But even this is not always sufficient; many other conditions are necessary; such as the choice of situation or matrix, atmospheric or meteorological momenta, and, above all, the season. If I can form any sure conclusion from some experiments which I have made during the microscopic investigation of *Botrytis Bassiana* (Muscardine), nature is not so peremptory in the lower fungi; for after having succeeded in separating upon the stage of the microscope a single sporidium, I have not only caused it to germinate and run through all the phases of its new existence, even to the production of the fruit; but what is more surprising, I have obtained, unexpectedly, the same result on a simple plate of glass placed under suitable conditions of light, heat, and moisture. The same experiment was equally successful in *Ascophora Mucedo*.

We have at last arrived at the production of the mycelium, which completes the circle, the first half of which is formed by the vegetation and the second by the fructification. To sum up: a fungus reduced to its simplest form is composed of a septate or continuous thread, terminated by a cell or nucleiferous swelling, which is the spore. If we would follow in thought all the modifications of these two organs, we may, by ascending constantly, as we have done, to-

* Corda, Pracht. Flora, p. 50.

wards beings more and more complicated, arrive at the very summit of the series, viz. *Amanita cæsarea.*

The various developments which the unfolding of this new subject for contemplation would allow of, would carry me beyond my object. Far from having exhausted, I have, alas! scarcely glanced over it. I leave this to those who are more capable. I could attempt only a feeble sketch; may it at least be sufficient to guide the reader in the midst of the numerous difficulties which await him in the study of this great and important class of the vegetable kingdom.

Paris, Feb. 1, 1841.

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## XXXIV.—*Observations on the Progress recently made in the Natural History of the* Echinodermata. By Prof. Agassiz.

[Continued from p. 197.]

In my 'Prodromus' I expressed doubts as to the membranous ambulacral tubes in the Sea-urchins having any relation to their powers of locomotion, grounding my opinion upon some observations which I had made on the sandy shores of Normandy, and upon the very positive assertion of Aristotle, who tells us that they move by the aid of their spines; and that even by the state of these organs their degree of progressive power may be known (liv. iv. chap. v.). Mr. Forbes, however, has shown this view of the matter to be erroneous, and has demonstrated that they also progress by means of their ambulacral tubes, especially when upon solid surfaces. In company with this gentleman I have seen them ascend, by the aid of these tubes, the perpendicular sides of a smooth glass vessel. No further evidence could be wanted to set at rest the point in question. It yet remains to be shown whether, among the *Cidarites*, the long club-shaped spines are not the principal organs of motion, and that it is among the Sea-urchins with very short bristles that the ambulacral tubes are essential to this function. M. de Siebold mentions the existence of microscopic cilia in the interior of these tentacula and of their vesicles (Mül. Archiv, 1836, p. 295). M. Ehrenberg, on the other hand, describes the vibratory movements in the membrane of the spines of *Echinus saxatilis* (movements which are denied by Mr. Forbes), and indicates the existence of an internal circulation of corpuscles, similar to the globules of blood, in the retractile tentacula upon the dorsal face of the *Asterias violacea*; he adds, moreover, that the surface of these tentacula is entirely covered with vibratile cilia (Mül. Archiv, 1834, p. 577). M. Volkmann has also given some new details upon the circulation in the *Asteriæ*,